

REMARKS

The undersigned thanks the Examiner for the interview November 3, 2003. During the interview, the undersigned pointed out to the Examiner that the position now taken in the Advisory Action of October 1, 2003 as to what are the unexpected results of this invention is a flip-flop from the position taken in the Action of September 2, 2003. Therefore, the undersigned told the Examiner that the Applicants have decided to either have this case reconsidered further in light of the attached Dieter Weller's article obtained from the Internet or file an appeal. The Examiner suggested that the Applicants should first file this Supplemental Response before filing an appeal.

Let us first look at the Examiner's position on the *facts* establishing unexpected results.

On page 5 of the Action of September 2, 2003, the Examiner states:

The examiner agrees that the applicant has shown that the *corrosion resistance* and *grain size distribution* of a recording medium is *improved* by the oxidizing a seedlayer that is formed directly adjacent the substrate and below a non-oxidized underlayer, and thus is improved over that of the structure shown by Taniyama alone. [Emphasis added.]

Then in the Advisory Action of October 1, 2003, page 4, the Examiner states:

While the examiner agrees [that] the applicant in table 1 shows that the *grain size* of a recording medium utilizing an oxidized seedlayer is *smaller* than [sic, than] that of a medium utilizing a non-oxidized seedlayer, this effect is not unexpected. This is clearly evident from the teachings of Suzuki and Bertero [Emphasis added.]

Clearly, the above two statements of the Examiner on issues of *fact*, not law, to first acknowledge and then refute unexpected results show that the Examiner has flip-flopped and lacks consistency even on issues of fact. For example, the Examiner first refers to "grain size

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distribution" in the Action of September 2, 2003 and then to "grain size" in the Advisory Action of November 1, 2003. Is "grain size distribution" the same as "grain size?" Clearly not! The term "grain size" refers to the mean of the size of the grains while "grain size distribution" refers to the ratio of sigma over mean, where sigma is the standard deviation of the grain size.

The Applicants respectfully submits that the Action of September 2, 2003, clearly indicates that the Examiner correctly recognized the unexpected results of this invention, namely "that the *corrosion resistance* and *grain size distribution* of a recording medium is improved." [Emphasis added.] In fact, an important unexpected result of this invention is the change in the *grain size distribution* with and without oxidized seedlayer as shown in Table 1 of the specification. This table is partially reproduced below wherein the grain size distribution is calculated to the third decimal place.

| | Grain Size Statistics without Oxidized Seedlayer | Grain Size Statistics with Oxidized Seedlayer |
|--|---|--|
| Mean | 10.3 | 9.7 |
| Standard Deviation | 2.7 | 2.2 |
| Grain Size Distribution (Standard Deviation/Mean) | $2.7/10.3 = 0.262 = 26.2\%$ | $2.2/9.7 = 0.227 = 22.7\%$ |

The table above shows that the grain size distribution *decreases* from 26.2% without the oxidized seedlayer to 22.7% with an oxidized seedlayer, which is a difference of 3.5%. What does this decrease mean to a person of ordinary skill in this art? Is it significant and unexpected? To understand the answers to these questions, please refer to the attached Dieter Weller's article entitled "FUTURE MAGNETIC RECORDING MEDIA," obtained from the Internet after the receipt of the Advisory Action by the undersigned.

The second paragraph of this article states:

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On the media side, the grain size distribution needs to be trimmed below 10% (sigma over mean), in order to reach grain-counts as low as five to ten grains per bit, as required in recent Tbit/in² perpendicular recording models. [Note that these are theoretical models.] Current state-of-the-art sputtered media have grain size distribution of about 25% and it remains an *open challenge* whether the required improvements can be obtained using physical, thin film sputtering processes. [Citations omitted.]

In short, the Weller article teaches that there is a gap of 15% between the grain size distribution of the current state-of-the-art sputtered media and that required in recent Tbit/in² perpendicular recording models. *This invention has successfully bridged this 15% gap by 3.5%, thereby bridging the gap by about 23%, which would have been totally unexpected before this invention.* This invention has partially solved the "open challenge" stated in the Weller article, and thus has also partially solved a long-felt need.

On page 4 of the Advisory Action of November 1, 2003, the Examiner states that "the *grain size* of a recording medium utilizing an oxidized seedlayer is smaller than [sic, than] that of a medium utilizing a non-oxidized seedlayer, this effect is not unexpected. This is clearly evident from the teachings of Suzuki and Bertero" Arguably, even if Suzuki and Bertero disclose about reduction in *grain size* by the use of an oxidized seedlayer, Suzuki and Bertero still do *not* disclose that the "*grain size distribution* of a recording medium is improved by the oxidizing a seedlayer that is formed directly adjacent the substrate and below a non-oxidized underlayer," which the Examiner has acknowledged in the Action of September 2, 2003 as an unexpected result of this invention.

In light of the above, a Notice of Allowance is respectfully solicited.

In the event that the transmittal letter is separated from this document and the U.S. Patent and Trademark Office determines that an extension and/or other relief is required, applicants

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petition for any required relief including extensions of time and authorize the Commissioner to charge the cost of such petitions and/or other fees due in connection with the filing of this document to Deposit Account No. 03-1952 referencing docket no. 146712001300.

Respectfully submitted,

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FUTURE MAGNETIC RECORDING MEDIA

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One of the key challenges to extending magnetic recording technology beyond the currently achieved 35-100 Gbit/in² areal densities is media noise suppression. It is well known that the conventional scaling approach, which is to reduce the media grain surface area in proportion to the bit cell surface area, is limited by the onset of super-paramagnetic instabilities in the media grains. Several options exist to avoid this problem. Traditionally, one has compensated the loss in grain volume by increasing the magnetic hardness (anisotropy); however, the write field of the recording head limits this approach. Anti-ferromagnetically coupled (AFC) dual-layer media have offered some relief by increasing the effective media thickness and consequently grain volume without compromising writability. The extendibility of this approach, however, appears to be rather limited. Three times smaller grain diameters, from currently about 9 nm down to about 3 nm, and correspondingly about ten times higher areal densities become feasible if writing magnetically much harder materials, such as face-centered-tetragonal FePt alloys, can be accomplished. A near term solution to enhancing the write field is being pursued in dual-layer perpendicular magnetic recording (PMR), where the field is 'focused' through the storage layer into a soft magnetic under-layer, thereby enhancing the field and at the same time sharpening the cross-track field gradient. Ultimately, in order to write such materials, however, some form of hybrid, heat-assisted magnetic recording (HAMR) is needed.

The other logical approach to enhancing the areal density in magnetic recording is to reduce the grain-count per bit. This approach will lead to higher media noise and will, among many other things, require significantly improved channel detectors. On the media side, the grain size distribution needs to be trimmed below 10% (sigma over mean), in order to reach grain-counts as low as five to ten grains per bit, as required in recent Tb/in² perpendicular recording models [1,2]. Current state-of-the-art sputtered media have grain size distributions of about 25% and it remains an open challenge whether the required improvements can be obtained using physical, thin film sputtering processes.

Self-organized magnetic array media (SOMA) based on chemical synthesis have that promise. Nearly mono-disperse structures of ferromagnetic FePt nanoparticles with mean diameters in the range 3-10 nm and room-temperature coercivities larger than 1 T have been reported [3]. Local (TEM) size distributions of better than 5% were found, but sample averaged magnetic properties suggest that distributions are far from ideal [2]. Control over these magnetic dispersions will be quintessential to achieving ultimately possible densities of 20-50 Tb/in².

[1] R. Wood, IEEE Trans. Magn., 36, 36 (2000).

[2] M. Mallory, A. Torabi, M. Benakli, IEEE Trans. Magn. (to be published, 2002)

[3] S. Sun, C.B. Murray, D. Weller, A. Moser, L. Folks, Science 287, 1989 (2000).